holes and electrons. On the way, the reader also encounters redox and free-radical reactions, which Atkins links together in a dazzling virtuoso display — a little too dazzling perhaps when the final conclusion is reached: “all the phenomena of the world are merely the reactions of one kind of acid with one kind of base”.

The driving force for chemical change leads us into thermodynamics, Clausius's principle, and the tendency towards chaos, and the virtues of coupled reactions. Although the fourth chapter opens with a discussion of Gibbs, his free energy is never encountered. Chemical equilibria are soon followed by the idea of reaction rates and energy barriers to reactions. The story moves swiftly from experimental observation to theoretical understanding in terms of molecular collisions, the dynamics involved in the making and breaking of chemical bonds, classical trajectories, Polanyi's rules for energy use and disposal (although Polanyi is not mentioned), tunnelling, isotope effects, diffusion-controlled reactions, catalysis at surfaces and ‘femtochemistry’. All this is accomplished in 25 sparkling pages — a *tour de force* and a delight.

Atkins begins the sixth chapter with an introduction to chemical reaction kinetics and rate equations, but halfway through the going becomes decidedly tough as autocatalysis, nonlinear rate processes, oscillating reactions and chaos are encountered. The medium is the famous but highly complex Belousov-Zhabotinskii reaction which Atkins discusses in some detail. Light relief comes at the end of the chapter with the association of concentration waves and animal-colouring waves that produce, for example, tigers' stripes and leopards' spots. This is a giant leap from Harcourt and Esson's rate law.

The next two chapters deal with the mechanisms of organic chemical reactions, and their description in terms of reactive intermediates, changes in electron distributions, proton transfers and sequences of small changes that can be amplified to larger ones. Atkins clearly explains the profound importance of orbital symmetry in providing a rationale for the preferred reactivity and stereochemistry of concerted molecular reactions where ring structures are generated, opened or closed. But without the Woodward-Hoffmann rules, which Atkins does not detail, it is not easy to explain why ethylene molecules do not readily bond together or why the addition of ethylene to butadiene helped to make Otto Diels and Kurt Alder famous.

The book closes with a chapter on photobiology, embracing luminescence, lasers and photosynthesis (the sections

on lasers might have been better placed with those on reaction dynamics). The account of photosynthesis, although pulling no punches, is clearly developed and illustrated, and forms a fitting conclusion to a grand concept. *Atoms, Electrons and Change* deserves to be read widely, even if the author believes its conception to be only “the consequence of a chemical reaction”. □

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Touching on the future

Claes G. H. Rooth

Global Changes of the Past. Edited by Ray Bradley. *Office for Interdisciplinary Earth Studies**. 1991. Pp. 514. \$38.

Paleoclimatology. By Thomas J. Crowley and Gerald R. North. *Oxford University Press*: 1991. Pp. 346. £45, \$59.95.

THE study of the character and causes of climate variations, as well as efforts to divine their future trends, has blossomed over the past few decades from an obscure activity pursued by a few enthusiasts into a rapidly growing and exciting area of science. The foundations for a physically and dynamically based theory of climate were laid in the recent maturation of several quite disparate specialities such as micropalaeontology, biogeochemistry and weather forecasting using computers.

Quantification of the different features of climate relies on statistical descriptions of the highly variable weather scene. Although the definition of these features in legal and economic practice is usually based on a 30-year period, we are increasingly aware of their long-term variability. As guides to the facts about such variability, these two books should be useful to a wide variety of users, be they researchers, policy-makers or broadly interested seekers of information about our environment. What awaits us in the future is touched on only in the broadest terms, however, and appropriately so, because natural variability, the causes of which are still poorly understood, is difficult to distinguish from the effects on the environment for which we humans have been responsible.

Our knowledge of past climates is still largely based on ingenious use of circumstantial evidence, but the interpretation

of this evidence is increasingly restricted by what is allowed by physical models. But although there are some absolute constraints, the models remain highly abstracted and so baconian interplay between developments in observation and theory is called for. This is brought forth in *Global Changes of the Past*, a collection of 20 tutorial presentations prepared for the second Global Change Institute meeting held at Boulder, Colorado, in 1992.

The volume also includes a set of working-group assessments of future climate, as well as recommendations about what action we should be taking. These are not very different from much that has been expressed elsewhere, but they provide a compact overview of the field, and thus a useful introduction for the novice. Although there is no overall consistency in style, the tutorial chapters contain state-of-the-art reviews of most if not all of the key components of current climate research. In general they are well written, illustrated and referenced. The book's main limitations lie in the areas of computational climate modelling and research into biogeochemical processes.

In *Paleoclimatology*, Crowley and North make considerably heavier fare, and succeed admirably in presenting an authoritative and lucid review of diverse material. The complementary backgrounds of the authors in geology and physics have enabled them to sweeten the usually dry flavour of reviews of geological and micropalaeontological data with plenty of dashes of good ideas and insights. For this the reader is prepared by an introductory review of elementary models of climate systems, and of the basic dynamics (including numerical modelling) of the large-scale oceanic and atmospheric circulations. At the same time, the otherwise mostly speculative forecasting by computer models of possible climates for epochs far from our own is given credence by being presented in a well-integrated way. The book is illustrated generously and well, which with the authors' easily flowing writing style makes it rewarding to the browser and keeps it interesting for those searching for a deeper understanding. But because of its broad scope, the serious student will probably need to search further. In this respect, the book's listing of more than 1,200 text references and almost 40 reference works will come in handy. Nevertheless, the work is complete enough to be both a standard reference for an audience ranging from researchers and students to environmental planners, and an excellent source for science communicators. □

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